ARMY
15.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

The US Army Research, Development, and Engineering Command (RDECOM) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Web site: https://www.armysbir.army.mil.

Solicitation, topic, and general questions regarding the SBIR Program should be addressed according to the DoD Program Solicitation. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the Solicitation. To obtain answers to technical questions during the formal Solicitation period, visit https://sbir.defensebusiness.org/. Specific questions pertaining to the Army SBIR Program should be submitted to:

John Smith
Program Manager, Army SBIR
army.sbir@us.army.mil
US Army Research, Development and Engineering Command (RDECOM)
6200 Guardian Gateway
Suite 145
Aberdeen Proving Ground, MD 21005-1322
TEL: (866) 570-7247
FAX: (443) 360-4082

The Army participates in three DoD SBIR Solicitations each year. Proposals not conforming to the terms of this Solicitation will not be considered. Only Government personnel will evaluate proposals with the exception of technical personnel from San Jose State University Research Foundation who will provide Advisory and Assistance Services to the Army, providing technical analysis in the evaluation of proposals submitted against Army topic number:

- AMRDEC(A)-151-004 Linear Inflow Model Synthesis for Advanced Rotorcraft Configurations, San Jose State University Research Foundation

The individual from San Jose University Research Foundation will be authorized access to only those portions of the proposal data and discussions that are necessary to enable them to perform their respective duties. This institution is expressly prohibited from competing for SBIR awards and from scoring or ranking of proposals or recommending the selection of a source. In accomplishing their duties related to the source selection processes, the aforementioned institution may require access to proprietary information contained in the offerors' proposals. Therefore, pursuant to FAR 9.505-4, this institution must execute an agreement that states that they will (1) protect the offerors' information from unauthorized use or disclosure for as long as it remains proprietary and (2) refrain from using the information for any purpose other than that for which it was furnished. These agreements will remain on file with the Army SBIR program management office at the address above.

PHASE I PROPOSAL SUBMISSION

SBIR Phase I proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments.

Small businesses submitting a Phase I Proposal must use the DoD SBIR electronic proposal submission system (https://sbir.defensebusiness.org/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

The small business will also need to register at the Army SBIR website https://portal.armysbir.army.mil/SmallBusinessPortal/Default.aspx in order to receive information regarding proposal status/debriefings, summary reports, impact/transition stories, and Phase III plans.

Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 20-page limit.

Only the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. The CCR is generated by the proposal submission website, based on information provided by you through the Company Commercialization Report tool. **Army Phase I proposals submitted containing a Technical Volume over 20 pages will be deemed NON-COMPLIANT and will not be evaluated. It is the responsibility of the Small Business to ensure that once the proposal is submitted and uploaded into the system it complies to the 20 page limit.**

Phase I proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase I proposals will be reviewed for overall merit based upon the criteria in Section 6.0 of the DoD Program Solicitation.

15.2 Phase I Key Dates

Solicitation closes, proposals due	24 Jun 2015
Phase I Evaluations	26 Jun – 26 Aug 2015
Phase I Selections	28 Aug 2015
Phase I Award Goal	22 Oct 2015

**Subject to the Congressional Budget process*

PHASE I OPTION MUST BE INCLUDED AS PART OF PHASE I PROPOSAL

The Army implements the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to have the Phase I Option exercised. The Phase I Option, which **must** be included as part of the Phase I proposal, should cover activities over a period of up to four months and describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option must be included within the 20-page limit for the Phase I proposal.

PHASE I COST VOLUME

A firm fixed price or cost plus fixed fee Phase I Cost Volume ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete Phase I Cost Volume not to exceed a maximum dollar amount of $100,000 and six months and a Phase I Option Cost Volume not to exceed a maximum dollar amount of $50,000 and four months. The Phase I and Phase I Option costs must be shown separately but may be presented side-by-side in a single Cost Volume. The Cost Volume DOES NOT count toward the 20-page Phase I proposal limitation. When submitting the Cost Volume, complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal.

PHASE II PROPOSAL SUBMISSION

Commencing with Phase II's resulting from a 13.1 Phase I, invitations are no longer required. Small businesses submitting a Phase II Proposal must use the DoD SBIR electronic proposal submission system (https://sbir.defensebusiness.org/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

A single Phase II proposal can be submitted by a Phase I awardee only within one, and only one, of four submission cycles shown below and must be submitted between 4 to 17 months after the Phase I contract award date. Any proposals that are not submitted within these four submission cycles and before 4 months or after 17 months from the contract award will not be evaluated. Any follow-on Phase II proposal (i.e., a second Phase II subsequent to the initial Phase II effort) shall be initiated by the Government Technical Point of Contact for the initial Phase II effort and must be approved by Army SBIR PM in advance.

SUBMISSION CYCLES	TIMEFRAME
Cycle One	30 calendar days starting on or about 15 October*
Cycle Two	30 calendar days starting on or about 1 March*
Cycle Three	30 calendar days starting on or about 15 June*
Cycle Four	30 calendar days starting on or about 1 August*

*Submission cycles will open on the date listed unless it falls on a weekend or a Federal Holiday. In those cases, it will open on the next available business day.

Army SBIR Phase II Proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 38-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes), data assertions and any attachments. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 38 page limit. As with Phase I proposals, it is the proposing firm's responsibility to verify that the Technical Volume does not exceed the page limit after upload to the DoD SBIR/STTR Submission site by clicking on the "Verify Technical Volume" icon.

Only the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report (CCR) are excluded from the 38-page limit. The CCR is generated by the proposal submission website, based on information provided by you through the Company Commercialization Report tool.

Army Phase II Proposals submitted containing a Technical Volume over 38 pages will be deemed NON-COMPLIANT and will not be evaluated.

Army Phase II Cost Volumes must contain a budget for the entire 24 month Phase II period not to exceed the maximum dollar amount of $1,000,000. During contract negotiation, the contracting officer may require a Cost Volume for a base year and an option year. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Volume Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

Small businesses submitting a proposal are required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal.

DoD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DoD Program Solicitation very carefully. Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of the solicitation.

BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Volume whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

FOREIGN NATIONALS

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 3.5 of this solicitation for definitions of “lawful permanent resident” and “protected individual”] as key personnel, they must be clearly identified. **For foreign nationals, you must provide country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Please ensure no Privacy Act information is included in this submittal.**

OZONE CHEMICALS

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the Cost Volume for Phase I ($100,000 maximum), Phase I Option ($50,000 maximum), and Phase II ($1,000,000 maximum), under “CMRA Compliance” in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://cmra.army.mil/.

- The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

  (1) Contract number, including task and delivery order number;
  (2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
  (3) Estimated direct labor hours (including sub-contractors);
  (4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
  (5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
  (6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
  (7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

- According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

DISCRETIONARY TECHNICAL ASSISTANCE

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed nine Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

For more information go to: https://www.armysbir.army.mil/sbir/, then click on Transition Assistance/Technical Assistance.

As noted in Section 4.22 of this solicitation, firms may request technical assistance from sources other than those provided by the Army. All such requests must be made in accordance with the instructions in Section 4.22. It should also be noted that if approved for discretionary technical assistance from an outside source, the firm will not be eligible for the Army's Technical Assistance Advocate support.

COMMERCIALIZATION READINESS PROGRAM (CRP)

The objective of the CRP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CRP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CRP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II availability of matching funds, proposed transition strategies, and individual contracting arrangements.

NON-PROPRIETARY SUMMARY REPORTS

All award winners must submit a non-proprietary summary report at the end of their Phase I project and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:

- A summation of Phase I results
- A description of the technology being developed
- The anticipated DoD and/or non-DoD customer
- The plan to transition the SBIR developed technology to the customer
- The anticipated applications/benefits for government and/or private sector use
- An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions posted within the Army SBIR Small Business Portal at https://portal.armysbir.army.mil/SmallBusinessPortal/Default.aspx and is due within 30 days of the contract end date.

ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) Submit two copies of the approved scientific or technical report delivered under the contract to the

Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://www.dtic.mil.

ARMY SBIR PROGRAM COORDINATORS (PC) and Army SBIR 15.2 Topic Index

Participating Organizations	PC	Phone
Aviation and Missile RD&E Center (AMRDEC-A)	Dawn Gratz	256-842-8769
Armaments RD&E Center (ARDEC)	Benjamin Call	973-724-6275
Army Research Lab (ARL)	Francis Rush Charles Ober	301-394-4961 301-394-1015
Communication-Electronics Research, Development and Engineering Center (CERDEC)	Joanne McBride	443-861-7654
PEO Soldier	Melisa Mahoney Daniel Rowell	703-704-1297 703-704-0654
Space and Missile Defense Command (SMDC)	Gary Mayes	256-955-4904
Tank Automotive RD&E Center (TARDEC)	Martin Novak	586-282-8730

DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST

This is a Checklist of Army Requirements for your proposal. Please review the checklist to ensure that your proposal meets the Army SBIR requirements. You must also meet the general DoD requirements specified in the solicitation. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award**. Do not include this checklist with your proposal.

1. The proposal addresses a Phase I effort (up to **$100,000** with up to a six-month duration) AND an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

2. The proposal is limited to only **ONE** Army Solicitation topic.

3. The technical content of the proposal, including the Option, includes the items identified in Section 5.4 of the Solicitation.

4. SBIR Phase I Proposals have four (4) sections: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in others sections of the proposal submission as THESE WILL COUNT AGAINST THE 20-PAGE LIMIT. ONLY the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. As instructed in Section 5.4.e of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the “Company Commercialization Report” tool. Army Phase I proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated.

5. The Cost Volume has been completed and submitted for both **the Phase I and Phase I Option** and the costs are shown separately. The Army prefers that small businesses complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Volume (offerors are instructed to include an estimate for the cost of complying with CMRA).

7. If applicable, the Bio Hazard Material level has been identified in the Technical Volume.

8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

9. The Phase I Proposal describes the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

10. If applicable, Foreign Nationals are identified in the proposal. An employee must have an H-1B Visa to work on a DoD contract.

Army SBIR 15.2 Topic Index

A152-090 TITLE: Linear Inflow Model Synthesis for Advanced Rotorcraft Configurations

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop and validate a method to numerically determine accurate linear state-space inflow models from physics-based aerodynamic models of advanced rotorcraft configurations.

DESCRIPTION: Current linear rotorcraft flight dynamics models are dependent on finite-state inflow theory based on potential flow modeling at the rotor plane [1]. These inflow models have few parameters and are readily available in linear state-space form, making them easy to implement in flight dynamic models for stability assessment and control system design studies. These types of models have been developed for [2] and extensively used in [3] modeling single main rotor helicopters. The future Army rotorcraft fleet will include configurations beyond the traditional single main rotor/trail rotor helicopters (e.g., tiltrotors and compounds) and advances in simulation modeling are required. Physics-based inflow models (e.g. free-vortex wake models, CFD, VPM, etc.) provide a more accurate and wholly generic representation of the rotor wake and can capture interference effects between the rotor and other rotors [4], other lifting surfaces, the fuselage, and the ground [5]. Rotor interference effects become critical when the wake of one rotor system is immersed in another, such as in coaxial helicopters. The physics-based models are nonlinear and so are limited in their use in flight dynamics and control studies. State-space inflow models of coaxial configurations have begun to be developed, but validation data is limited and needs to be improved in forward and maneuvering flight [6, 7]. A method to numerically determine a real-time linear state-space model directly from physics-based models that captures the key interference effects would provide a pathway for accurate model development and improved stability analysis and control law design of advanced configurations. The goal of the effort will be to develop and validate a methodology to determine linear time-invariant (LTI) parametric inflow models from physics-based models for any rotorcraft configuration. The parametric model should include interference effects of other aircraft components. The inflow model should be easily included in existing rotorcraft simulation tools. The methodology should be applicable to not only single main rotor helicopters, for which linear inflow models exist, but be generic and easily extendible to coaxial, compound, or other rotorcraft configurations. The validation should consist of wake and full aircraft dynamics comparisons (e.g. time histories, frequency responses, trim analysis, etc.) with higher-order models, the non-linear simulation from which the model was derived, and experimental/flight data, if available. The methodology developed would reduce the iterative nature of control law design and lead to cost savings and increased efficiency in the development process of aircraft flight control systems. The feasibility for determining accurate linear inflow models for advanced rotorcraft configurations and an initial model structure will be established in Phase I. If the ability is confirmed, Phase II will fully develop the capability. The primary interests of this study are (1) linearization capability, (2) accuracy, and (3) scalability of parameter representations. There are broad dual-use applications for a linear representation of advanced rotorcraft inflow dynamics. Major military rotorcraft manufactures all have multi-rotor aircraft and other advanced configurations in use or development. The inflow modeling of these configurations has proven to be problematic and a key barrier to proper predictive capability of the aircraft flight dynamics characteristics.

PHASE I: Determine the feasibility to extract a real-time parametric linear inflow model for advanced rotorcraft configurations from a physics-based model that includes interference effects of other aircraft components. Propose an initial model structure and compare to other inflow model types and document the advantages and disadvantages of each method. Describe the methodology that will be used to obtain the model and all simplifications or assumptions needed to produce the linear model. Describe the process that will be used to obtain time history and frequency response data for validation.

PHASE II: Develop and validate a software tool that implements a numerical method to generate parameterized LTI state-space inflow models for use in rotorcraft flight dynamics analysis. The tool should require generic inputs, including aircraft states and control inputs, and be able to correctly predict the inflow at the rotor(s) in both hover and forward flight. The model should be applicable to a range of physics-based models. Demonstrate the derived model in a flight dynamics simulation of a representative test aircraft. Compare results of this model with prior work using finite-state and higher-order models, including predictions of transient response with flight test data. Model predictive capability will be evaluated by comparing time histories and frequency responses of the high-order and linear models. Time histories should provide an error of 25% or less, and the frequency responses should have costs of less than 100 [8]. Provide documentation for incorporation of this model with existing flight dynamics modeling tools.

PHASE III: Transition the tool for commercial use with military and industry customers. Since the developed tool is generic, it will be compatible with each customer's existing physics-based inflow models. The government will use the tool to develop accurate flight dynamics models to support handling qualities (through piloted simulation) and control law development for advanced rotorcraft configurations. Industry customers could use the tool for similar purposes.

REFERENCES:
1. Pitt, D.M., and Peters, D. A., "Theoretical Prediction of Dynamic Inflow Derivatives," Vertica, Vol. 5, (1), 1981, pp. 21-34.

2. Peters, D.A, and HaQuang, N., "Dynamic Inflow for Practical Applications," Journal of the American Helicopter Society, Vol. 33, (4), October 1988, pp. 64-68.

3. Kim, F.D., Celi, R., and Tischler, M.B., "Forward Flight Trim and Frequency Response Validation of a Helicopter Simulation Model," Journal of Aircraft, Vol. 30, (6), November-December 1993, pp. 854-863.

4. Juhasz, O., Syal, M., Celi, R., Khromov, V., Rand, O., Ruzicka, G.C., and Strawn, R.C., "A Comparison of Three Coaxial Aerodynamic Prediction Methods Including Validation with Model Test Data," American Helicopter Society Aeromechanics Specialists Meeting, San Francisco, CA, January 2010: to appear in the Journal of the American Helicopter Society.

5. Griffiths, D.A., Ananthan, S., Leishman, J.G., "Prediction of Rotor Performance in Ground Effect Using a Free-Vortex Wake Model," Journal of the American Helicopter Society, Vol. 50, (4), October 2005, pp. 302-314.

6. Nowak, M., Prasad, J.V.R., and Peters, D.A., "Development of a Finite State Model for a Coaxial Rotor in Forward Flight," American Helicopter Society 70th Annual Forum, Montreal, Canada, May 2014.

7. Zhao, J., and He, C., "Real-Time Simulation of Coaxial Rotor Configurations with Combined Finite State Dynamic Wake and VPM," American Helicopter Society 70th Annual Forum, Montreal, Canada, May 2014.

8. Tischler, M.B, and Remple, R.K., "Aircraft and Rotorcraft System Identification: Engineering Methods with Flight Test Examples," AIAA, 2nd Edition, 2012, Reston, VA.

KEYWORDS: Inflow, rotor wake, state-space, linear model, flight dynamics, simulation, control, helicopter

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A152-091 TITLE: Innovative Motion Measurement Package (M2P) for Guided and Un-Guided Munitions

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Ammunition

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop an innovative sensor package that can be used by munitions to accurately measure its properties during gun launch and during flight with negligible impact to the munition.

DESCRIPTION: Performance of future munitions are dependent upon the accurate estimation of the airframe's angular motion, acceleration about each axis, velocity and roll position relative to up. The M2P will reside within the munition airframe and measure actual projectile/airframe properties, which can be used by the munitions guidance package and/or fuzing system. The M2P technology can utilize conventional sensor technology but however, must also include novel technology that will enhance measurements as compared to current methodologies. Data such as launch conditions need to be accurately predicted in order for the M2P package to be able to integrate rates and accelerations in order to accurately predict the projectile's attitude. The projectile's M2P package shall not include GPS. The M2P sensor technology needs to function during gun launch shock environment and reliably measure, collect, and transmit data to the appropriate munition sub-system. The solution must be of such small size as to fit within the very limited volume claim (ideally within a 1 cubic inch volume) of the airframe and utilize existing power supply (ideally less than one watt). Life expectancy of the technology shall be at least 20 years.

PHASE I: Identify all gun launch environmental effects and factors the projectile experiences. From these factors the contractor shall formulate and laboratory verify the technologies that are capable of accurately measuring the motion of the projectile during and after gun launch. The contractor will perform and document design analyses to demonstrate compliance with requirements listed above. The results of Phase I will include an engineering analysis of alternatives noting the design capabilities and limitations and recommendations for the Phase II effort, as well as recommendations for the physical prototypes to be built in the laboratory and subjected to laboratory functional testing.

PHASE II: Based on success in Phase I, the contractor shall refine the selected design(s) to meet functional and environmental requirements. The contractor will design and build a minimum of 10 prototypes and provide to the government. At the Government's discretion these prototypes may undergo air and/or rail gun testing culminating in a ballistic test (live fire). Deliverables include the 10 prototypes, an engineering report on the design selected in the contractor's format.

PHASE III: The topic author envisions that the LOS/BLOS Division within ARDEC's Munitions Engineering and Technology Center will incorporate and test the developed technology in a time-fuzed munition. A need may exist to provide analysis, instructions, process control documents, and design that can be used by Army engineering to integrate the Phase II technology into a selected munition for further performance evaluations. To this end, the contractor may be requested, if funds are available, to design and build a minimum of 10 prototype sensor packages to be integrated into an Army selected munition. This munition may undergo air and/or rail gun testing culminating in a live-fire ballistics test.

REFERENCES:
1. US Army Test and Evaluation Command Operations Procedure, "Projectile Velocity Measurements" (Top 4-2-805) http://www.dtic.mil/dtic/tr/fulltext/u2/a119554.pdf

2. M256 120mm Smoothbore Gun, www.inetres.com/gp/military/cv/weapon/M256.html

3. M1A1/2 Abrams Main Battle Tank, United States of America, Army Technology.com project description (http://www.army-technology.com/projects/abrams/)

KEYWORDS: Sensors, fuzing, guidance, airframe, munition,

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A152-092 TITLE: Enhanced Analysis for Pulsed Voltammetry Evaluation Tool / System for Improved Power Systems

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Soldier

OBJECTIVE: Design the required algorithms and user interface to simulate and analyze a full pulsed voltammetric response curve to allow for quantitative determination of electrochemical behavior and performance of power systems.

DESCRIPTION: In order to develop new high-performance batteries, fuel cells, and sensors, the electrochemical behavior of materials and devices need to be quantitatively assessed. This assessment (models and systems characterization) will help identify the performance of electrochemical systems leading to the development of significantly improved power sources. New electrochemical analysis tools will enable better characterization of electrodes, electrolytes, and devices. Often only a few data points from a voltammogram or working curves for each experimental condition are used to determine, the formal potential and peak current. These analyses can be imprecise due to background currents, multiple redox processes, etc. Pulse voltammetry not only reduces charging currents but can also be mathematically described and modeled. To date a limited set of fundamental models have been developed to describe the pulsed voltammetric response for complex mechanisms and electrode geometries using the data contained in the complete voltammogram. Additional models need to be developed and these techniques made accessible to the research community using a generalized approach that can easily determine relevant electrochemical parameters from datasets obtained by modern instrumentation. In particular, it is not possible to determine the reversible half-wave potential, the charge transfer coefficient, the heterogeneous charge transfer rate, or the diffusion coefficient from the entire voltammogram. A tool is needed that is able to quantify electrochemical parameters using a variety of pulse profiles and would enable enhanced understanding of the behavior of redox couples and resultant devices such as batteries, fuel cells, and electrochemical sensors. Furthermore, the algorithms must be able translate between different types of instrumentation and new pulse based voltammetry techniques. These tools would be integrated into commercial electrochemistry data generation and analysis packages.

PHASE I: Develop models and measurement / characteristic tools that can determine reversible half-wave potential, the charge transfer coefficient, the heterogeneous charge transfer rate, and the diffusion coefficient for single square wave voltammograms. The resultant tool should allow the parameters to be calculated entirely from the voltammograms (with user provided initial values) or allow individual variables to be set by the user and the other variables calculated based on the voltammogram. In addition, the package should determine the confidence/uncertainty for the calculated electrochemical parameters.

PHASE II: Incorporate additional models to allow utilization of data from a variety of pulse voltammetry techniques including: normal pulse, reverse pulse, and differential pulse voltammetry, as well as coupled electrochemical and chemical mechanisms such as preceding chemical reaction, following chemical reaction, catalytic chemical reaction, etc. The algorithm should also be capable of determining the electrochemical parameters from a "bundled" series of voltammograms with for example varying square wave frequency. Verify with statistical confidence intervals the accuracy of the data obtained. Integrate the models and evaluation tools into commercial electrochemistry data generation and analysis package that will assist in determining prospective solutions performance.

PHASE III: This product would be used in a broad range of military and civilian research with applications including: advanced batteries, electrosynthesis, electrocatalysis, and detectors to provide decisions on which technologies to further develop for improved electrochemical power sources.

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KEYWORDS: Electrochemistry, Pulsed voltammetry, Battery, Fuel cell

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A152-093 TITLE: Techniques for Wire Recognition using mmW

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The goal is to develop techniques or algorithms of automatically recognizing wires and power lines in the millimeter wave radar image regime.

DESCRIPTION: Rotorcraft landing and takeoff is dangerous in environments where obstacles, particularly wires or power lines exist, and pilot vision is degraded by obscurants such as dust, smoke, fog, rain and snow. This SBIR would focus on a radar solution to detecting wires and power cables when landing in a visually degraded environment. Existing data for wires and power lines with millimeter wave radars produce either curtains or periodic bright spots through the bragg effect when used in traditional real beam imaging. However, if the sensor is capable of penetrating an obscurant and has an automated technique to recognize a power line or wire, the sensor can simply send data to an independent imager to nominally represent a wire without the need to image it. The development of a technique or algorithm to recognize wires at a variety of approach angles will improve the Army’s capability of operation in degraded visual environments.

PHASE I: Phase I will investigate an approach to recognizing wires, including wires from 3/8” up to bundled high power transmission lines, from angles of incidence of 0 degrees (head on from the sensor) to 45 degrees angle of incidence from the sensor. The techniques proposed will utilize previously collected fully calibrated government furnished sensor data in the millimeter wave radar regime (W band).

PHASE II: Phase II will further develop and refine techniques or algorithms /software to demonstrate the ability to detect and identify wires using the approaches laid out in Phase I. The laboratory demonstration will include formatted and calibrated W government supplied data with approaches to wires from a range of angles of incidence. The Phase II effort shall be capable of detecting bundled high power transmission lines (threshold) down to 3/8” smaller wires (objective), from angles of incidence of 0-20 degrees (threshold) and up to 45 degrees (objective) from detection ranges of 150 meters (threshold) out to 2 kilometers (objective).

PHASE III: Phase III will build on the laboratory demonstration from Phase II to include integration with a W band radar sensor and a synthetic vision system to provide a full detection and visualization system for pilot situational awareness on rotary wing aircraft. The proposers will also consider other military applications including applications to fixed wing and UAV operations to enhance capabilities in degraded visual environments. Commercially, this capability enhancement can transition to the commercial aircraft industry for passenger airlines as well as the shipping industry. The end state system will also increase aircraft survivability for both private industry first responders and emergency medivac helicopter transports, as well as military pararescue aircraft in urban areas where wires may impact helicopter survivability. The end state system is directly applicable to sensor fusion efforts in the RDECOM Degraded Visual Environment Mitigation Program and can transition to PM Aviation. The technology, as it matures, can also transition to meeting the needs of Future Vertical Lift expected capabilities (survivability and enhanced capability in all weather, all environments) and expected mission tasks including enhancing the survivability medical pararescue rotary wing aircraft

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KEYWORDS: Millimeter Wave, wires, degraded visual environments, aircraft survivability

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A152-094 TITLE: Adaptive Visual Camouflage for the Individual Soldier

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop an innovative adaptive camouflage technology that can be used by individual Soldiers in various land environments. A non-powered solution is preferred.

DESCRIPTION: The Army uses camouflage to protect Soldiers and equipment from observation by enemy forces and to enhance stealth operations. Conventional camouflage is designed to conceal the Soldier using two basic elements: color and pattern. The one pattern fits all environments approach, however is not ideal. The U.S. Army Training and Doctrine Command Pamphlet 525-66 [1] identifies force operating capabilities necessary for the Army to fulfill warfighting concepts. It mentions that “Future Modular Force Soldiers will need a light, non-bulky ‘smart’ uniform/suit that will provide a ‘chameleon-like’ camouflage capability”. A chameleon-like or adaptive camouflage system would continuously update the color and pattern, concealing the Soldier in the current environment. Such technology would greatly enhance Soldier survivability. “A major goal of the US Military is the development of a high tech camouflage that can change color and pattern with its environment [2].” In the past, several adaptive camouflage technologies for Army Infantry application have been in development. These included Retro-reflective Projection Technology where the image behind an individual is projected on retro-reflective material if font of the individual essentially making a invisible cloak effect, Organic Light Emitting Diodes on flexible surfaces, Liquid Crystal on flexible displays, polymer and metal-foil substrates with printable Thin Film Transistor backplanes, and electro-chromic materials that change color when an electrical current is passed through it [3, 4]. Unfortunately all of these technologies have limitations mainly with the large amount of power and computing power required. More recent research in adaptive camouflage or “Invisibility Cloaks” involves the use of metamaterials to manipulate the paths of light around objects. Metamaterials are artificial materials engineered to have properties not found in nature. They are assemblies of conventional materials such as metals or plastics arranged in complex repeating patterns. These materials get their properties not from their composition, but from their intricately designed structures [5, 6]. The problem with these materials is that it takes very time consuming methods to fabricate. Recently however researchers discovered a way to develop a stamp-based printing method for generating large pieces of the material.

PHASE I: The Phase I effort should focus on the feasibility of a 360 degree coverage adaptive wearable visual camouflage technology for the individual Soldier that can actively respond to various land environments under changing light conditions. The focus of the research should be on scientific approaches and fundamental mechanisms of the technology. The technology must be able to be integrated with Soldiers' equipment. A non-powered solution is preferred; however a powered solution should last a minimum of four hours and weigh no more than two pounds including power source and accessories. The adaptive technology should meet current near infrared reflective requirements. Technology must operate in complex terrain (desert, forest, urban areas, jungle, and mountains) and in all weather conditions from extreme temperatures, greater than 95F and less than 32F, and high winds to precipitation ranging from none to heavy as well as operating in conditions with a variety of obscurants such as smoke, dust, and fog. Deliver monthly research status reports and a final report documenting the entire research and development effort along with a detailed description of the adaptive technology and a preliminary design.

PHASE II: Refine the preliminary design developed in Phase I. Develop a minimum of 10 prototypes that demonstrate the technology of the preliminary design for government testing and evaluation. A powered solution should last a minimum of eight hours and weigh no more than one pound including power source and accessories. Compare current camouflage patterns to newly developed adaptive technology using current NATO evaluation procedures and metrics [7, 8]. Investigate and develop how the technology will integrate with Soldiers' equipment. Perform a human factors test to ensure that the technology is comfortable and feasible in a simulated combat environment and to ensure that it can integrate with Soldiers' clothing and equipment. Study the temperature effect of the technology given the temperature range that a Soldier may experience. Investigate the durability and reliability of the technology. Study possible manufacturing methods, processes, and quality control methods to efficiently produce the adaptive camouflage. At the completion of this phase, the technology readiness level (TRL) should be TRL 6.

PHASE III: Scale up the technology demonstrated in Phase II for individual Soldier adaptive camouflage for full scale production and transition to Program Executive Office (PEO) Soldier's program of record – Soldier Protection System. Establish a manufacturing infrastructure through an industry partnership or in-house capability. Establish quality assurance processes and procedures to ensure consistent raw material properties. Establish quality assurance testing and inspection processes and procedures to ensure consistent product properties. Establish how to maintain production lot control with the raw materials. Develop manufacturing procedures for all processes. Establish process control parameters for all manufacturing processes.

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8. RTO-TM-SCI-095 - Enhancement of Camouflage Assessment Techniques

KEYWORDS: Camouflage, Adaptive Camouflage, Active Camouflage, Dynamic Camouflage, Invisible Cloak, Camouflage Concealment, Camouflage Pattern, Detection Probability

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A152-095 TITLE: Avian Vision Processing

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop a single lens capability which mimics the visual acuity of a bird of prey and exhibits the following attributes: single aperture, man-portable (i.e. hand-held), and variable focal length. System will be able to detect targets automatically, and provide distance to detection. Concept should facilitate image acquisition such that information can be displayed and analyzed with a computer system.

DESCRIPTION: Birds of prey, also known as raptors, are birds that hunt or feed on other animals. They are characterized by keen vision that allows them to detect prey during flight. Since vision is the most important sense for birds, and good eyesight is essential for safe flight, this group has a number of adaptations which give visual acuity superior to that of other vertebrate groups. The objective of this SBIR is to develop an innovative solution which will allow the operator to achieve the same sort of superior imaging and improved situational awareness available to avian predators. The effective focal length (EFL) of the imaging system itself should be able to change; simple digital magnification of an image does not provide the kind of image clarity discussed here. While variable focal length lenses have been demonstrated (see references), shortcomings have been identified both in the range of the EFL shift and in the resolution capabilities of the system. The intent of this effort is to push the boundaries of this technology and achieve extreme shift and resolution. This EFL shift should be maximized, with a minimum EFL of no more than 40mm, and a dynamic shift of 10x (threshold), 100x (objective). Time for EFL shift will be considered; while there is no rigid time requirement, the lens must be able to shift across it''s full dynamic range quickly (80% at 1000m. False alarms are to be minimized as much as possible. Image processing must be conducted on a man-portable computer system (laptop or smaller). Once detected, range to the target must be determined. Range is to be accurate to +/- 1m within 1000m. While passive range finding via computer vision (see reference) is preferred, active range finding (to include laser range finding) is permitted, however the ranging must be done automatically (i.e., the operator isn''t tasked with aiming a laser, the system instead aims and range-finds for the operator).

PHASE I: Investigate innovative optical solutions for imaging systems. Develop and document the overall optic component design and accompanying algorithms for operation/alteration of the lensing system. Develop support documentation for the lensing medium. Demonstrate a proof of principle of the design by producing a preliminary architecture concept (for example, lens size, sensor size/density) where image acquisition information can be displayed and analyzed with a computer system. Phase I deliverables will include: Monthly status reports, Final phase report, and demonstration hardware.

PHASE II: Develop and demonstrate a prototype capability for insertion into a realistic, Government-supplied imaging system. The component must be capable of demonstrating key operational parameters (in particular alteration of EFL) in a laboratory environment. Include analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Identify representative components that are not yet integrated. Demonstrate ability to automatically locate and track a target within the imager's field of view. Demonstrate the ability to accurately determine range to that target. Phase II deliverables will include: Monthly status reports, Final phase report, and prototype system (TRL 5/6) demonstrating functionality of lens, target detection, and rangefinding.

PHASE III: Protoype system validation in a realistic (outdoor, controlled range) environment. Components are integrated into a meaningful form factor, and in a package which is robust enough for Soldier use. System size, weight, and power will be optimized for functionality and reliability. Manufacturability assessment will be conducted. Intent for this technology is to transition to the Fire Control family of systems, particularly the Fire Control-Squad and Fire Control-Precision Programs of Record (POR's). Commercial opportunities (to be defined by vendor in proposal) will be explored.

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KEYWORDS: Optics, Photonics, Lens, Focal Length, Visual Acuity, Focal Time, Image Acquisition, Detection

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A152-096 TITLE: Advanced Coordinated Control, Formation Flying for Nano-Satellite Applications

TECHNOLOGY AREAS: Space Platforms

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Design, develop and demonstrate innovative concepts for a distributed aperture RF/EO system embedded in formation flying nano-satellites with state-of-the-art position knowledge, accuracy, control, and communications/connectivity.

DESCRIPTION: The focus and priority of this topic is seeking innovative space-based remote sensor capabilities supporting all-weather, day-night imaging capability. Preliminary research assessments highlight the availability of next generation device/component technologies and outline novel approaches for creating flotillas, swarms, and/or formations of nano-satellites with multi-faceted functions and sensor capabilities. While each individual satellite should have a specific sensor or control function, the overall formation/swarm should have a greater function and be "greater than the sum of its parts." Of particular interest are solutions with multiple onboard processing computer clusters, very high bandwidth communications architectures, imagery collection/dissemination, SAR/ISAR, MASINT, and GPS alternatives. Current small satellites such as cubesats are limited with power due to size and weight issues. Of particular interest is new power storage, collection, handling, and distribution concepts that will enable higher power components for communications and active sensors. Power requirements for a distributed aperture RF/EO system must be determined in order to develop a flotilla craft design. Solutions should target the goals defined here and should be scalable across a network of mobile ground, air, sea, and space devices.

PHASE I: Research and develop novel approaches to demonstrate the feasibility of the end goal of performing distributed RF/EO apertures using nano-satellites. The Phase I effort should consist of a study effort to determine if current nanosat capabilities can be implemented to demonstrate this goal from low Earth orbit. Assess through analysis the Technology Readiness Level (TRL) of the proposed concept at the conclusion of Phase I.

PHASE II: Based on the verified successful results of Phase I, refine and extend the proof-of-concept design into a fully functioning pre-production prototype. Verify the TRL at the conclusion of Phase II.

PHASE III: Develop the prototype into a comprehensive solution that could be used in a broad range of military and civilian applications where rapid RF/EO imagery is required. There are no particular requirements on data resolution at this time. This demonstrated capability will benefit and have transition potential to Department of Defense (DoD) weapons and support systems, federal, local and state organizations as well as commercial entities. For instance, a swarm of commercial nanosatellite sensors could be used to monitor crops, roadways, etc. or a team of floating EO sensors could be deployed in waterways to inspect the integrity of dams and levees, or to monitor the smuggling of illegal contraband in US waters.

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KEYWORDS: attitude control, propulsion, formation flying, nano-satellites

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A152-097 TITLE: Underbody Blast, Crash and Rollover Interior Impact Injury Prevention Technologies

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: To prevent mounted warfighter head and neck injury due to occupant impacts with military vehicle interior roof surfaces during underbody blast, crash and roll-over events. Technology solution is light weight, non-intrusive, requires minimal vehicle packaging space and is durable.

DESCRIPTION: Non-traditional interior roof military vehicle impact injury prevention technologies address the challenge to provide warfighter survivability, allowing them to complete their mission, by preventing impact related injuries such as skull fractures and neck injuries, otherwise incurred during underbody blast, crash and rollover events. The solution accounts for the full range of occupants to include the 5th female, 50th male, and 95th male occupant sizes. Additionally it takes into account the occupant may be wearing the ACH helmet and additional gear worn on the body of the occupant. The occupant shall be considered restrained during the blast event. Injury data from theater shows mounted warfighter head, neck and upper spine injuries due to occupant impacts with the vehicle interior during blast, crash and rollover events, frequently occur (Head Injury Analysis for DOT & E Study, JTAPIC RFI 2013-N0114, 10APR2013 and 2012-N0161 Blast Injury Prevalence Rate BIPSR, 10JAN2013). Injuries to the head include traumatic brain injuries (TBI) primarily concussions, skull fractures, face fractures and neck/upper spine fractures. The focus of this topic is to reduce injuries related to skull and neck fractures. Traumatic brain injuries are out of scope of this topic. Although it can be assumed that if impact energy is mitigated to reduced fractures, TBI’s related to occupant impacts is also likely to be reduced. Non-traditional technologies may include, and are not limited to; active protective technologies, optimized interior geometric design and a durable, flame resistant exposed surface allowing protection for multiple impact directions. Interior impact protection shall be developed for military vehicle applications, such as; the HMMWV (High Mobility Multi-purpose Wheeled Vehicle, AMPV (Armored Multiple Purpose Vehicle), Abrams, Bradley Fighting Vehicle, Stryker, 20 T Truck and HTV (Heavy Transport Vehicle). Non-traditional technologies are needed to address military vehicle design trade-offs such as; i) minimizing vehicle packaging space claims and non-intrusive designs, and ii) lighter weight than traditional technologies such as energy absorption materials.

PHASE I: Phase I entails a feasibility study, concept development, analysis and modeling and simulation, risk analysis, cost analysis and concept design of a non-traditional, roof-mounted impact injury protection mainly focused upon head and neck injury protection. The concept shall utilize one of the US Army tactical and one ground combat vehicle such as; HMMWV (High Mobility Multi-purpose Wheeled Vehicle, AMPV (Armored Multiple Purpose Vehicle), Abrams, Bradley Fighting Vehicle, Stryker, 20 T Truck and HTV (Heavy Transport Vehicle) as the basis for concept development, which are ITARS Export Controlled. Non-traditional technologies will be designed to provide impact protection at AIS (Anatomical Injury Score) of 2 or less. The technology shall provide impact injury protection from multi-directional impacts, have a durable, flame resistant exposed surface and be non-intrusive ensuring the technology does not hinder or encroach upon the mounted warfighter.

The technology shall be capable of providing occupant head-neck protection in less than 15 milliseconds, given an impact velocity of 15 miles per hour (24 kilometers per hour). The energy attenuation criterion for head impact protection, will achieve less than 700 HICd (Head Injury Criterion) using the test evaluation method and equipment per FMVSS 201U. HICd is calculated in accordance with the following formula taken from JSSG-2010-7 Crew Systems Crash Protection Handbook (208): Where A_R=[A_x^2+A_y^2+A_z^2]^(1/2) Resultant Acceleration magnitude in g units at the dummy head cg. t1 and t2 are any two points in time during the impact event which are separated by not more than a 15 millisecond time (FMVSS 49 CFR 571 208: Occupant Crash Protection, 2013.10.01). Neck impact injury protection shall be designed according to SAE J885, Feb 2011-02, section related to Direct Impact to the Neck and Neck injury due to head inertia loading. Neck impact injury protection shall provide a maximum peak flexion bending moment about the occipital condyle shall not exceed 190 Nm. The maximum peak extension bending moment about the occipital condyle shall not exceed 57 Nm. The maximum peak axial tension shall not exceed 3300N. The maximum peak axial compression shall not exceed 4000 Newtons. The maximum peak fore and aft shear shall not exceed 3100 Newtons. The neck moments are calculated form the following formula: MOCY =MY – FX(0.01778m), where: MOCY = moment y about occipital condyle MY = measured moment from load cell FX = measured force from load cell Durability criterion is to not degrade in performance when exposed to temperatures of MIL-STD-810 Basic Hot and Basic Cold Storage temperatures, humidity and tracked vehicle vibration schedules. The technology concept shall be developed with the intent to not incur holes from abrasion, tear or puncture after being tested to ASTM D2582, ASTM D751, ASTM D2261, ASTM D3384, ASTM 966 or ASTM D1242 or similar standard, based upon the exposed surface sheet material composition, at 1,000 cycles. The technology concept shall be developed with an exposed surface designed to prevent an overhead dripping and melting injuring the occupant, and shall not generate significant heat index, rapid flashing (ignition greater than 15 seconds) or flame spread, smoke or toxicity when exposed to large fire per ASTM E1354 at 50 kW/m2< 200 flaming and non-flaming, FAR 25.853 and have toxicity approval from the U.S. Public Health and Safety Department and TARDEC. When active technologies are being considered/used for innovative technology development, the technology shall be developed with consideration for ASTM D5428-08 Standard Practice for Evaluating the Performance of Inflatable Restraint Modules, ASTM D5427-09 Standard Practice for Accelerated Aging of Inflatable Restraint Fabrics, ASTM D7559/D7559M-09 Standard Test Method for Determining Pressure Decay of Inflatable Restraint Cushions, ASTM D5807-08 (2013) Standard Practice for Evaluating the Over-pressurization Characteristics of Inflatable Restraint Cushions, ASTM D6476-12 Standard Test Method for Determining Dynamic Air Permeability of Inflatable Restraint Fabrics, ASTM D6799 Standard Terminology Relating to Inflatable Restraints.

Analytical tools such as Finite Element Analysis and modeling and simulation, shall be used for concept development including pulse development. The outcome of Phase I shall include the scientific and technical feasibility as well as the commercial merit for the technology(s) solution provided. The concept(s) developed shall be supported by sound engineering principles. Supporting data, initial test data, along with material safety data sheets and material specifications shall also be included if available. The projected development and material cost and timing shall be included in the study.

PHASE II: Phase II of this effort shall focus upon the validation and correlation of the analytical concepts and pulses developed from Phase I, along with technology prototype fabrication and validation laboratory testing and evaluation. Military vehicle application(s) and integration concepts will be further refined for one or more military vehicle, such as the the HMMWV (High Mobility Multi-purpose Wheeled Vehicle, AMPV (Armored Multiple Purpose Vehicle), Abrams, Bradley Fighting Vehicle, Stryker, 20 T Truck and HTV (Heavy Transport Vehicle). Vehicle specific prototype component design, modeling and simulation analysis as well as early fabrication for purposes of laboratory verification and vehicle interface evaluation. The energy attenuation performance of the technology solution(s) for head-neck impact injury protection shall be in accordance with the criterion in Phase I, and shall be verified during Phase II. Laboratory testing with prototype concept hardware shall also verify the technology solution(s) capability to withstand military vehicle environment and climates for durability and flame, smoke and toxicity resistance as described in Phase I. The technologies shall be designed to be securely attached to the vehicle roof in areas of the vehicle where occupant head-neck impact is projected to occur based upon modeling and simulation. Vehicle packaging space shall be considered relative to the 5th percentile female through to the 95th percentile male, and analysis conducted to verify the occupant's space requirements are met in accordance with MIL-STD-1472. This system has the potential to be utilized in any Military and Civilian truck and automotive applications. Technology risks and risk mitigation plans shall be clearly identified; design guidelines and lessons learned shall be documented. Any required modifications and re-testing shall be conducted during Phase II.

PHASE III: In the final Phase of the project the contractor shall prove out the effectiveness of the system on the AMPV, Stryker, HTV and/or Bradley Fighting Vehicle for underbody blast, crash and rollover conditions, integration, environment, and durability. The technology solutions designed in Phase I and II to a variety of military vehicles, will be tailored specifically for the military specific vehicles for ease of transition to fielded vehicle solutions. Technology risks and risk mitigation plans shall be clearly identified; design guidelines and lessons learned shall be documented. Any required modifications and re-testing shall be conducted during Phase III. Manufacturability shall be verified during Phase III. This system has the potential to be utilized in any Military and Civilian truck and automotive applications, as well as potential naval applications. Additionally the technology will be applicable to commercial automotive and locomotive industries.

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KEYWORDS: Impact Protection, Injury protection, head-neck injury, HICd, Head Injury Criterion, active, non-traditional, innovative, energy attenuating, light weight, ATD (Anthropomorphic test device), fire resistant, non-traditional, innovative, novel, airbag, geometry

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A152-098 TITLE: Variable Energy Ignition System for Heavy Fuel Rotary Engine

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Future Army vehicles require small, lightweight, efficient heavy fuel engines. Rotary (Wankel) engines offer these benefits but have reliability restrictions, especially with its ignition system. This program's objective is to develop a variable energy ignition module system to improve component reliability.

- Size: 1.5 Liters
- Weight: 4.5 lbs
- Power Consumption: 120W
- Output (plug) channels: 5
- Fully controllable: Energy output, timing

DESCRIPTION: There currently is a shortcoming for heavy fuel engines that have a rated power below 100 BHP that are compatible with both JP-8 and DF-2, have high power to weight and power to volume density, provide good fuel consumption characteristics, and operate over extreme climatic ranges ranging from below -25 F to 125 F ambient. One developing technology that could potentially fit this niche market are spark ignited heavy fuel, rotary diesel engines that can provide from 10 BHP to 50 BHP per rotor, have best brake fuel consumption less than 0.5 lbm/bhp-hr, and have an engine power density of 1 hp/lbm for small ground vehicles. A major challenge with such engines is the combustion system development, of which the ignition system is a critical element. This is due to the ignition source's direct contact with injected fuel and the complex fuel and air flow path characteristics. There are significant performance and reliability gains with a high energy ignition event at low engine speeds and startup, compared to low ignition energy at high speed conditions. The performance requirements for this ignition system SBIR are as follows:

- Variable output: 50 - 200 mJ / spark
- Response Time: 2000 Hz
- Ambient Temperature Range: -25 F to 125 F
- Size: 1.5 Liters
- Weight: 4.5 lbs
- Power Consumption: 120W
- Output (plug) channels: 5
- Fully controllable: Energy output, timing

PHASE I: Identify and assess ignition system components and design approach. Design a brass board ignition module for simulated workbench use.

PHASE II: Develop and build two generations of ignition system prototypes. Demonstrate and validate the performance stated in the topic description through computational analysis, bench top experimentation, and relevant engine hardware demonstration. The system shall be controllable via a software interface. Demonstrations shall be completed in a laboratory environment with the TARDEC Combat Vehicle Prototype (CVP) program Advanced Auxiliary Power. The Advanced Auxiliary Power Program utilizes a 700cc heavy fuel rotary engine to produce 45kW of electric power.

PHASE III: Develop and build a hardened prototype ignition system module capable of meeting MIL-STD-805C environmental standards. The ignition system shall be readily integrated onto the CVP program, transition mechanism to the Future Fighting Vehicle (FFV). The resulting ignition system could be available for rotary diesel engines used in future Army unmanned ground and aerial vehicles that have power requirements ranging from 20 – 100 BHP while improving in performance and reliability from the current state of the art.

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KEYWORDS: ignition, module, system, spark, plug, variable, rotary, wankel, engine, jp-8, df-2

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A152-100 TITLE: Low Cost, Low Temperature Processing, High Use Temperature Composite Material

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Ammunition

OBJECTIVE: There is a need for low cost composite materials that can operate across the entire spectrum of armament temperatures. These temperatures can range from -70F to over 800F. Besides operating across this temperature range, these materials must be low cost and be able to be combined with traditional metallic materials.

DESCRIPTION: There is an emphasis on lightweight systems; however, many armament systems have use-temperatures that exceed traditional organic, composite systems. Specialty polymers can extend the range to 700F, but are expensive and hard to process. High-use temperature composites include pre-ceramic polymers, ceramic matrix and metal matrix composites. All of these are expensive and hard to process. This effort focuses on developing a composite system which is low cost and can be processed at low temperatures while still having a high-use temperature. The processing temperature must be low enough so as to not cause coefficient of thermal expansion mismatch issues with steel substrates.

PHASE I: Develop a composite material system that demonstrates low cost, low processing temperature and high-use temperature. Demonstrate its capabilities by producing mechanical test results across the entire temperature range of interest. ASTM D3039 (Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials), D3410 (Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials with Unsupported Gage Section by Shear Loading), D2344 (standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates), and either D3518 (Standard Test Method for In-Plane Shear Response of Polymer Matrix Composite Materials by Tensile Test of a +/- 45° Laminate) or D5379 (Standard Test Method for Shear Properties of Composite Materials by the V-Notched Beam Method) should be used to generate these properties. If a novel material that is not a polymer matrix composite is developed, then appropriate test standards may be substituted. The material deliverable shall be 25 lbs of developed material in a continuous fiber form that can be processed on existing filament winding or tape placement equipment. The use-temperature must range from -70F to at least 800F, preferably 1000 F. The material should be physically and environmentally stable across the entire temperature range. Cost of the system should be same or lower than standard temperature thermoset materials.

PHASE II: Refine the material system and demonstrate high temperature stability by testing material samples at elevated temperatures. Property goals at room temperature in the fiber direction shall be a tensile strength of 200 ksi, a tensile modulus of 25 Msi, a compressive strength of 100 ksi, and a compressive modulus of 20 MSI. The interlaminar shear strength shall be equal to or greater than 9 ksi and any deviation from this value shall be reported and a plan to achieve 9 ksi shall be described. Shear modulus and strength, along with transverse properties, shall be measured as well. At 800F, properties in all directions shall not decrease by more than 20%.

PHASE III: Finalize the development of a material based solution that can be readily implemented on existing manufacturing equipment. Non-DoD applications include down well piping, engine components, etc.

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KEYWORDS: Advanced composites, High Temperature composites, low cost composites

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